REMARKS

Reconsideration of this patent application is respectfully requested in view of the foregoing amendments and the following remarks.

The amendments to this patent application are as follows. Claim 1 was amended to recite that "the traveling magnetic field being the single type of magnetic field which is applied to the melt." Support for this Amendment to claim 1 can be found in Examples 1 and 2 and in Fig. 1 to which the examples are referring in the present Specification.

Newly added independent claim 14, is based upon process claim 1, and further recites subject matter found in the paragraph bridging pages 9 to 10 of the present Specification, as follows: "the magnetic field is due to three coils which are connected to a 3-phase power supply, and the traveling magnetic field which, in the region of the crucible wall, exerts a substantially vertically oriented force on the melt is generated by suitable selection of an order of connections; and the connections of the coils have a phase angle in an order 0^0 -60^0 - 120^0 or 0^0-120^0-240^0."

The Patent Examiner has repeated and made Final the previous Restriction Requirement. Thus claims 5 to 13 have been withdrawn from further consideration.

The Applicants comment upon the prior art rejections as follows. Claims 1- 2 are rejected under 35 U.S.C. 102(b) as being anticipated by *Iida et al* (*US Patent No.6,077,343*). Claims 1-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Tamatsuka et al* (*US Patent No.6,139,625*) in view of *Luter et al* (*US Patent No. 6,053,974*) along with *Szekely et al* (*US Patent No. 5,196,085*).

Claims 3-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Iida et al* (*US Patent No. 6,077,343*) as applied to claims 1-2 above, and further in view of *Kawanishi et al* (*US Patent No. 6,086,671*). These rejections are respectfully traversed.

The *Iida et al U.S. Patent No. 6, 077,343* in column 8 in lines 54 to 63 discloses that a magnetic field can be applied when a crystal is grown by the CZ method. According to such MCZ method, with an effect of doping nitrogen, the pulling rate is shifted to a higher range, and the N-region is significantly

enlarged.

As a magnetic field applied to a silicon melt, a horizontal magnetic field, a vertical magnetic field, or a cusp magnetic field is used. A magnetic field having a strength of 2000 G or more, preferably 3000 G or more may be applied, since a magnetic field less than 2000 G can achieve too small an effect for the application of the magnetic field.

Also *Iida* from column 10 line 63 to column 11 line 3 discloses that a so-called MCZ method has often been employed. When the MCZ is employed, an unillustrated magnet is disposed outside the pull chamber 31 in a horizontal orientation so as to apply a magnetic field to the silicon melt 2 in a horizontal or vertical direction or in a like direction. Through the application of the magnetic field to the silicon melt 2, convection of the melt 2 is suppressed to thereby stably grow a single crystal.

Thus *Iida* fails to teach or to suggest a traveling magnetic field, as claimed, for a crucible having a diameter of at least 450 mm and for a crystal pulled with a diameter of at least 200 mm.

The *Szekely U.S. Patent No. 5,196,085* in column 3 in lines 31 to 43 discloses that in FIG. 2, a Czochralski crystal growth system 30 is shown wherein a stationary external magnetic field, B_o whose axial upward or downward direction is indicated by arrow 32 is applied selectively at the growing crystal surface vicinity 35 in combination with a moving magnetic field provided by induction coils 36 which also act as heaters. The moving magnetic field serves to stir melt 38 contained within crucible 40 characterized by radius, R_c 42, while applied external stationary axial magnetic field, B_o damps disturbances in crystal surface vicinity 35 as growing crystal 44 characterized by radius, R_x 46, is withdrawn from melt 38.

Thus *Szekely* fails to teach or to suggest a traveling magnetic field, as claimed.

The *Kawanishi U.S. Patent No. 6,086,671* from column 3 line 65 to column 4 line 6 discloses a method for growing a silicon single crystal which comprises melting a silicon starting material charged in a crucible while applying a static magnetic field, contacting a seed crystal with a surface of the silicon melt, and solidifying the melt while pulling upwardly.

The term "static magnetic field" used herein is one that is

established by application of a steady-state current or by means of a magnet without suffering any change in relation to time and which is able to suppress the flows of the melt.

Thus *Kawanishi* fails to teach or to suggest a traveling magnetic field, as claimed.

The *Luter U.S. Patent No. 6,053,974* from column 2 line 53 to column 3 line 3 discloses apparatus which is a heat shield for use in a crystal puller around a monocrystalline ingot grown out of a crucible in the crystal puller filled with molten semiconductor source material. The heat shield comprises a reflector having a central opening sized and shaped for surrounding the ingot as the ingot is grown to reduce heat transfer from the crucible. The reflector is adapted to be supported in the crystal puller between the molten material and a camera aimed toward at least three separate points on a meniscus formed between the ingot and an upper surface of the molten material. The reflector has at least three passages extending through the reflector. Each of the passages is located along an imaginary line extending between the camera and one of the points on the meniscus. This permits the camera to view the points so the positions of the points can be determined by the camera for calculating the diameter of the ingot while minimizing heat loss

through the passages.

Thus *Luter* fails to teach or to suggest a traveling magnetic field, as claimed.

The *Tamatsuka U.S. Patent No. 6, 139,625* in column 6 in lines 11 to 35 discloses a rapid heating rapid cooling apparatus in FIG. 3 which is a schematic view of a rapid heating/rapid cooling apparatus.

A heat-treatment furnace 10 shown in FIG. 3 includes a bell jar 1 which is formed from, for example , silicon carbide or quarts and in which a wafer is heat-treated. Heaters 2 and 2' surround the bell jar 1 so as to heat the bell jar 1. The heater is separated along a vertical direction. Also, power supplied to each heater can be controlled independently. The heating method is not limited thereto, but so-called radiation heating and induction heating may also be applicable. A housing 3 as a heat shield is provided around the heaters 2 and 2'.

A water-cooled chamber 4 and a base plate 5 are arranged at the lower portion of a furnace so as to isolate the interior of the bell jar 1 from the atmosphere. A wafer 8 is held on a stage 7, which is attached to the top end of a support shaft 6, which,

in turn, is moved vertically by means of a motor 9. In order to load a wafer into or unload from the furnace along a horizontal direction, the water-cooled chamber 4 has an unillustrated wafer port which is opened and closed by means of a gate valve. A gas inlet and a gas outlet are provided in the base plate 5 so that the gas atmosphere within the furnace can be adjusted.

Thus *Tamatsuka* fails to teach or to suggest a traveling magnetic field, as claimed.

In addition to all of the above, it is specifically pointed out that among the prior art which was cited by the Patent Examiner only one document, namely *Szekely et al. (US-5,196,085)* mention that melt stirring can be accomplished magnetically e.g. by inducing vertical motion with a traveling field. Therefore, this reference, is considered to be the prior art which is closest to the present invention.

In order to more distinctly point out the invention, claim 1 was amended to recite:

A process for producing a silicon single crystal, comprising pulling a silicon single crystal from a silicon melt which is contained in a crucible having a crucible wall and having a

crucible diameter of at least 450 mm,

placing a heat shield above said crucible; and said silicon single crystal being pulled with a diameter of at least 200 mm; and

exposing the silicon melt to an influence of a traveling magnetic field which exerts a substantially vertically oriented force on the melt in a region of the crucible wall, said

traveling magnetic field being the single type of magnetic field which is applied to the melt.

Szekely et al. do not teach the claimed process. This is because the disclosure of *Szekely* is limited to the teaching that the melt is stirred by imposing a traveling magnetic field to the melt and applying an axial magnetic field (CUSP field) to ensure a laminar melt flow and quiescent conditions in the vicinity of the melt-crystal interface. (Please see column 2, lines 17-33).

The axial magnetic field (CUSP field) is not a component of the present invention. To the contrary, and according to the present invention, low-frequency temperature fluctuations decreasing the yield are attenuated due to the action of the traveling magnetic field. As stated in the Specification text, low-frequency temperature fluctuations are responsible for dislocations developing in the growing crystal (Please see page

11, first paragraph of the present Specification).

Accordingly, if a static CUSP field as taught by *Szekely et al.* is applied in addition to the traveling magnetic field, the convection enhancing action of the traveling field is counteracted by the CUSP field. This CUSP field according to *Szekely et al.* (column 2, lines 19-21) ensures laminar flow and quiescent conditions in the vicinity of the melt-crystal interface and accordingly acts quite contrary to the traveling field. Therefore, an important difference between the *Szekely* prior art reference and the claimed invention of claim 1 is the absence of any other type of magnetic field when a traveling magnetic field is applied to the melt.

This important difference in claim 1 is now recited by the recitation that the "traveling magnetic field is the single type of magnetic field which is applied to the melt."

With regard to newly added claim 14, none of the prior art references teach or suggest the recited subject matter that

"the magnetic field is due to three coils which are connected to a 3-phase power supply, and the traveling magnetic field which, in the region of the crucible wall, exerts a

substantially vertically oriented force on the melt is generated by suitable selection of an order of connections; and the connections of the coils have a phase angle in an order 0^0 -60^0 - 120^0 or 0^0-120^0-240^0."

For all these reasons, none of the prior art references provide an identical disclosure of the claimed invention. Hence the present invention is not anticipated under 35 U.S.C. 102. Withdrawal of this ground of rejection is respectfully requested.

In summary, claim 1 has been amended and new claim 14 has been added. In view of these amendments, the present invention, and all the claims, are firmly believed to be patentable under 35 U.S.C. 103 over all the prior art applied by the Patent Examiner. A prompt notification of allowability is respectfully requested.

Respectfully submitted,

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Enclosures: 1) Petition Two Month Extension of Time
2) Copy of Petition

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: COMMISSIONER FOR PATENTS, P.O. Box 1450, Alexandria, VA 22313-1450 on August 29, 2003.

Maria Guastella